

Clinical Medicine

Necrotizing Soft-Tissue Infections of the Perineum and Genitalia Etiology and Early Reconstruction

PETER R. CARROLL, MD; EUGENE V. CATTOLICA, MD; CHARLES W. TURZAN, MD, and
JACK W. McANINCH, MD, *San Francisco*

Necrotizing fasciitis of the perineum and genitalia is a rare, rapidly progressive, often fatal infection whose unique bacterial involvement has frequently been ignored. From our experience with 14 patients, we recommend the following: early, aggressive surgical debridement and drainage to reduce morbidity and mortality; prompt institution of antimicrobial therapy directed at both aerobic and anaerobic organisms, with subsequent tailoring to the specific bacteria cultured, and early surgical reconstruction to avoid extensive scarring and cosmetic deformity and to allow earlier skin closure and a reduced hospital stay. In our series, long-term complications occurred in 3 patients, and 3 of the 14 died.

(Carroll PR, Cattolica EV, Turzan CW, et al: Necrotizing soft-tissue infections of the perineum and genitalia—Etiology and early reconstruction. *West J Med* 1986 Feb; 144:174-178)

In 1883, Fournier¹ described an abrupt, rapidly progressive, gangrenous infection of the genitalia in 5 otherwise healthy young men, and since that time about 400 similar cases have been recorded.²⁻⁵ Such infections have been described as a variety of different syndromes.⁶ All probably represent a spectrum of disease best characterized as a fulminant soft-tissue infection that may spread along subcutaneous planes and be followed by necrosis of the skin, fascia or subcutaneous tissue (A. A. Meyer, MD, Associate Professor of Surgery, University of California, San Francisco, oral communication in May 1983). The manifestations will depend upon the focus of initial infection, the organisms involved and the length of time before presentation. Despite the development of newer antibiotics and improved methods of organ support, mortality and morbidity remain high.

We report our experience with necrotizing soft-tissue infections of the perineum and pelvis, emphasizing the mode of presentation, the bacterial involvement and the pathogenesis of the disease. We outline a unified method of diagnosis that may minimize mortality and morbidity in this high-risk group.

Patients and Methods

Between 1975 and 1982, 14 patients (13 men and 1 woman) presented to San Francisco General Hospital and Kaiser Permanente Medical Center in Oakland, California, with necrotizing soft-tissue infections of the perineum and genitalia. The average age was 52 (range, 18 to 81 years). All records were reviewed for clinical presentation, laboratory data (including culture results), method of treatment, length of hospital stay, complications and eventual outcome. Gram's stain results, when available, were reviewed and compared with subsequent findings on culture.

Results

Clinical Presentation

The patients presented with a variety of signs and symptoms (Table 1). The delay between the onset of local symptoms and presentation averaged 6 days (range, 1 to 30 days). Subcutaneous crepitus was evident in nine (64%) of the patients and confirmed by x-ray film in six (Figure 1). Actual skin breakdown, necrosis and shock were less common (Figure 2).

From the Departments of Urology, University of California, San Francisco [UCSF]; Kaiser Permanente Medical Center, Oakland, California, and San Francisco General Hospital Medical Center. Dr Carroll was Chief Resident in the Department of Urology, 1983 to 1984. He is now affiliated with the Department of Urology, Memorial Sloan-Kettering Cancer Center, New York. Dr Turzan is a Resident in Urology.

Presented in part at the 59th Annual Session of the Western Section of the American Urological Association, Inc., Vancouver, BC, July 1983.

Reprint requests to Jack W. McAninch, MD, Department of Urology, U-518, UCSF, San Francisco, CA 94143.

INFECTIONS OF THE PERINEUM

TABLE 1.—Clinical Presentation of Necrotizing Fasciitis of Perineum and Genitalia

| Signs and Symptoms | Patients | |
|-------------------------|----------|------------|
| | Number | Percentage |
| Pain | 14 | 100 |
| Swelling | 14 | 100 |
| Crepitus | 9 | 64 |
| Fever | 9 | 64 |
| Skin necrosis | 4 | 29 |
| Shock | 3 | 21 |

TABLE 2.—Bacteriologic Culture Results*

| Organism | Growth | | |
|--|--------|----------|-------|
| | Heavy | Moderate | Light |
| Anaerobic (Gram-positive) | | | |
| "Cocci" (total) | 5 | 2 | 2 |
| Streptococci | 3 | ... | 1 |
| Anaerobic (Gram-negative) | | | |
| <i>Bacteroides</i> sp (total) | 6 | 1 | 2 |
| <i>Bacteroides fragilis</i> | 1 | 1 | ... |
| <i>Bacteroides baderan</i> | 1 | ... | ... |
| <i>Bacteroides melaninogenicus</i> | 1 | ... | ... |
| Facultative Enterobacteriaceae (total) | 6 | 1 | 2 |
| <i>Escherichia coli</i> | 6 | 1 | 1 |
| <i>Klebsiella pneumoniae</i> | ... | ... | 1 |
| <i>Proteus</i> sp | ... | ... | 1 |
| Staphylococci (total) | ... | 2 | 2 |
| <i>Staphylococcus epidermidis</i> | ... | ... | 1 |
| <i>Staphylococcus albus</i> | ... | 1 | ... |
| Streptococci (total) | 3 | 1 | 5 |
| "Nonhemolytic" | 1 | ... | 3 |
| "Alpha" | ... | 1 | 2 |
| Group D | ... | ... | 1 |
| Group B | ... | ... | 1 |
| Group A | 2 | ... | ... |
| Group G | ... | ... | 1 |

*Several organisms were identified only according to their genus or group—that is, anaerobic cocci, *Staphylococcus* sp. The number of patients presenting with each organism is listed; several presented with more than one species of a particular group. Nine patients are represented in each group, with the exception of staphylococci, which were found in only 4.

Underlying or contributing conditions were noted in several patients, including alcohol abuse in eight (57%), diabetes mellitus in three (21%) and genitourinary disease in three (urethral stricture in two). The source of the infection was traced to the rectum in seven patients, the skin in four and the genitourinary tract in the two patients with strictures. The source was not precisely clear in one patient who died shortly after presenting with massive perineal and scrotal necrosis.

Laboratory Findings

Leukocytosis was almost uniformly present, averaging 20,000 leukocytes per μ l. Only two patients presented with hematuria or pyuria in excess of five cells per high-power field. Significant elevations in the blood urea nitrogen-to-creatinine ratio, exceeding 40:2, occurred in five patients (36%).

Results of tissue and wound cultures are summarized in Table 2. Although the genus was identified in all cases, the species was not noted in several culture reports. Infection tended to be polymicrobial, with an average of 3.4 organisms (range, 1 to 5) identified in each specimen. The common pathogens included anaerobic cocci, *Bacteroides* sp, faculta-



Figure 2.—Actual skin necrosis and breakdown in a patient who presented several days after the initiation of infection.

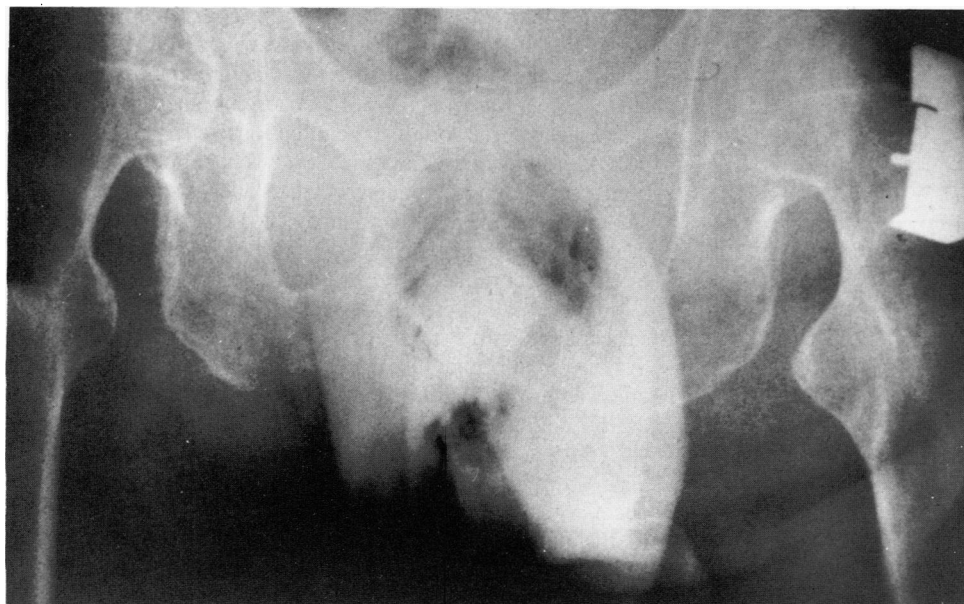


Figure 1.—Soft-tissue radiograph of the pelvic area showing subcutaneous gas.

tive Enterobacteriaceae and aerobic streptococci, each appearing equally in nine (64%) of the patients. The combinations most frequently found (seven patients each) included *Escherichia coli* with either *Bacteroides* sp or anaerobic cocci and *Bacteroides* sp with aerobic cocci. Of note was the finding of anaerobic bacteria in 11 patients (79%). The combination of aerobic streptococci and staphylococci was seen in only three (14%).

Treatment

All patients underwent repeated surgical debridement and drainage; the number of procedures required in each averaged 4.6. The debridement was carried into normal vascularized tissue in each case. The patients were returned to the operating room early, usually within 24 hours, for inspection and continued debridement until the necrotizing process had been interrupted. Diverting colostomy was necessary in four patients. Only one patient required unilateral orchiectomy for a necrotic testicle and spermatic cord.

Local reconstruction was successfully carried out in 11 patients (Table 3). All patients were treated with antibiotics, usually a combination of an aminoglycoside, high-dose penicillin and clindamycin. Intravenous hyperalimentation was used for nutritional support in selected patients.

Complications

Three of the patients died (21% of the series). Early complications are summarized in Table 4; delayed complications, seen in one patient each, included urethral stricture, infertility, urethral fistula and mild penile angulation. Two patients required surgical revision of their reconstructed wounds. The average hospital stay for those patients who survived was 48 days (range, 19 to 126 days). Clinical follow-up averaged 22 months.

TABLE 3.—Methods of Local Reconstruction After Surgical Debridement for Necrotizing Fasciitis of Perineum and Genitalia

| Reconstructive Methods | Patients* | |
|----------------------------------|-----------|------------|
| | Number | Percentage |
| Split-thickness grafts | 8 | 57 |
| Thigh pouches | 5 | 36 |
| Delayed closure | 4 | 29 |
| Skin flaps | 2 | 14 |

*Some patients underwent more than one method of reconstruction.

TABLE 4.—Complications of Necrotizing Fasciitis of Perineum and Genitalia

| Complications | Patients | |
|-----------------------------------|------------------|------------|
| | Number N = 14 | Percentage |
| Death | 3 | 21 |
| Renal failure | 6 | 43 |
| Respiratory failure | 4 | 29 |
| Cardiovascular collapse | 4 | 29 |
| Coagulopathy | 2 | 14 |
| Urethral stricture | 1 | 7 |
| Infertility | 1 | 7 |
| Fistula | 1 | 7 |

Discussion

Clearly, the limited description of necrotizing soft-tissue infections of the scrotum and genitalia proposed by Fournier¹ 100 years ago is not applicable today. These should not be considered idiopathic, nor are they confined to younger, previously healthy patients. The average age of recently reported cases is 50 years,² similar to our series. Many patients have associated predisposing conditions: diabetes mellitus and alcohol abuse seen in most of our patients may contribute to reduced host resistance and are common.^{2,7,8}

In the five cases described by Fournier,¹ no discernible focus of infection was found; in the 1972 report of Burpee and Edwards,⁹ the source was identified in only half, the rest being classified as idiopathic. More recently the focus of infection has rarely escaped detection. Only one of our patients failed to have a fully identifiable nidus. He presented moribund with massive perineal and scrotal necrosis and died a short time later. He was known to have had bright red rectal bleeding a few days before admission, suggesting a gastrointestinal focus. Indeed, the importance of the gastrointestinal tract as the source of the necrotizing process has been reported previously.^{3,4,10,11} Half of the patients in the present series had extension of a primary perirectal infection. The process penetrates the genitourinary diaphragm and microscopic interstices in Colles' fascia to extend to the genitalia.¹² Other foci of infection include the skin and periurethral glands,¹³⁻¹⁵ which represented 29% and 14%, respectively, in our study.

The bacteriology of necrotizing soft-tissue infection of the scrotum and perineum has not been emphasized in the past. Such knowledge gives insight into the pathogenesis of the disease and provides the basis for a routine treatment program. Maximum information will be obtained if Gram's stains are done and compared with both anaerobic and aerobic tissue or aspirate cultures; the Gram's stain will provide immediate information regarding the nature of the infecting organism. To some extent, the primary source of infection determines the bacterial flora encountered: those cases resulting from genitourinary tract disease and manipulation would be expected to show anaerobic Gram-positive cocci and staphylococcal and streptococcal species; infections resulting from primary colorectal disease will more commonly show gut-specific organisms such as *Bacteroides* sp.¹⁶

In the present series, the most common organisms included *Bacteroides* sp, *E coli*, anaerobic cocci and aerobic streptococci. Importantly, the infections were predominantly polymicrobial and anaerobic flora were cultured in 11 patients. The high percentage of anaerobes discovered in this study (79%) and in others suggests that reports of aerobic organisms alone may be due to improper anaerobic collection or culture techniques.^{2,6,17} Although clostridia are reportedly a frequent pathogen,⁶ none was discovered in the present series. Ten Gram's stain reports were available for review and a "few pleomorphic Gram-positive rods" were noted in only one, suggesting that the absence of clostridia was not due to faulty culture techniques.

The presence of multiple organisms in almost all cases—anaerobes and facultative Enterobacteriaceae and streptococci—suggests the probable importance of bacterial synergy in the development of necrotizing soft-tissue infections.¹⁸ Synergistic interaction has been shown in vivo and in vitro. Meleney¹⁹ first outlined such a relationship when he proposed

that the synergistic action of staphylococci and microaerophilic streptococci was responsible for progressive gangrene. Similar interactions have been described for a variety of organisms.²⁰⁻²²

The primary pathologic process appears to be the production of a vascular obliterative endarteritis, which leads to ischemia and subcutaneous necrosis. Both aerobes and anaerobes induce intravascular clotting, the former by fixing complement and the latter by producing heparinase.^{2,23} The decreased oxygen tension promotes growth of anaerobes and anaerobic metabolism by facultative forms. Increased anaer-

obic metabolism produces the relatively insoluble hydrogen and nitrogen gases that can be recognized radiographically or clinically as subcutaneous crepitus.²⁴

Three patients had only aerobic, Gram-positive cocci: two group A *Streptococcus* and one group G. An association with *Staphylococcus* was seen in one patient. It has been proposed that group A *Streptococcus* alone has the capacity to initiate necrotizing soft-tissue infections.¹⁸

Initial antibiotic treatment should be directed at both anaerobic and aerobic organisms until culture results are available. In the present study, this was usually accomplished by prescribing a combination of an aminoglycoside, high-dose penicillin and clindamycin. Alternative regimens, including third-generation cephalosporins, metronidazole and semisynthetic penicillins, may be effective and are under investigation.

Prompt surgical debridement is the focus of effective treatment (Figure 3). All patients were brought to the operating room promptly and examination was carried out under anesthesia to define more accurately the focus of infection and the extent of necrosis. Prudent debridement was done, removing all devitalized tissue. The patients were returned to the operating room early and frequently, usually within 24 hours, for reexamination and debridement until all devitalized tissue had been removed and the necrotizing process interrupted. A diverting colostomy should be constructed if perirectal involvement is extensive or if there is significant danger of continued wound contamination.

There is no rule for nonoperative treatment.²⁵ Surgical incisions and antibiotic irrigation are not advised. Kaiser and Cerra,²⁶ studying necrotizing fasciitis confined to a variety of areas, showed that mortality correlated positively both with the delay between recognition of infection and presentation and also with the type of surgical procedure done. Four patients treated with incision and drainage without debridement of necrotic tissue died, but 11 of 12 patients who underwent prompt debridement of necrotic tissue survived (a drop in the mortality rate from 100% to 8.3%).

Meticulous local wound care with either saline or Dakin's solution, soaked dressing changes and, in selected patients, enzymatic debridement is important. Vigorous wound care, often in the burn unit, provides for earlier tissue epitheliali-

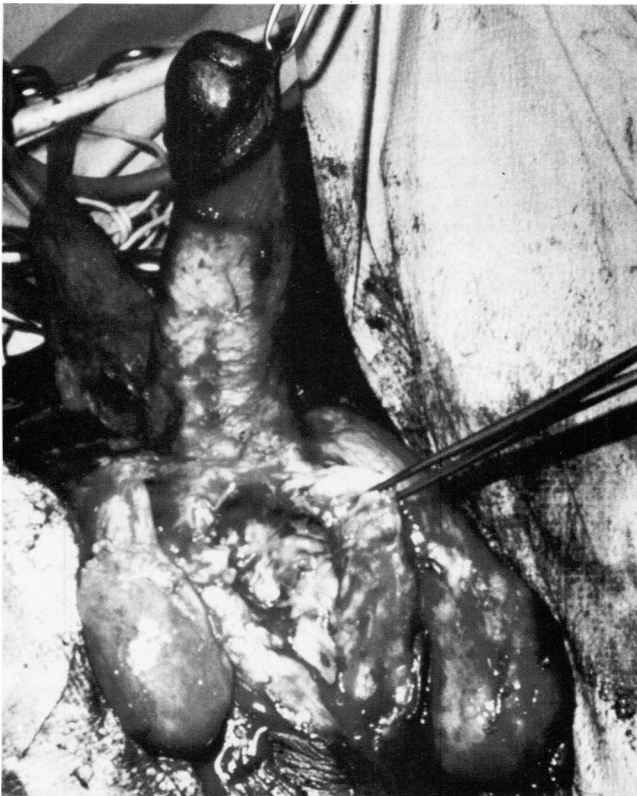


Figure 3.—Extensive local debridement in a patient who presented 6 days after traumatic Foley catheterization for urethral stricture disease.

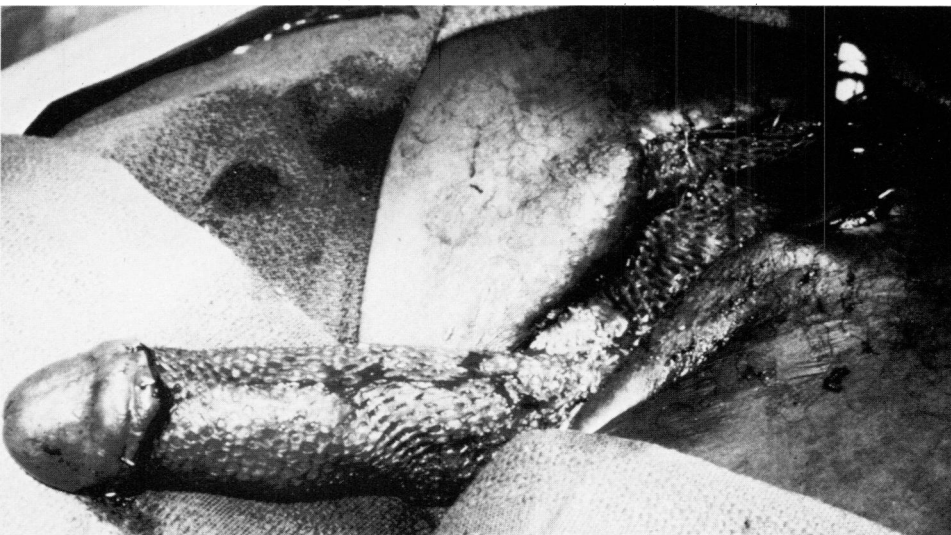


Figure 4.—Split-thickness skin grafting in the patient depicted in Figure 3.

zation and allows early reconstruction. Hyperbaric oxygen has been used by several authors, but its efficacy has never been proved conclusively.^{6,11,27} It was not used in the present series, and it should neither replace nor delay surgical intervention.

Despite extensive infection, necessitating wide debridement, early and adequate local reconstruction was accomplished in the majority of cases. Due to the redundant nature of the scrotal skin, delayed closure of the scrotum was possible in four patients. Split-thickness skin grafting allowed for coverage of the large defects without significant scarring or cosmetic deformity in eight patients (Figure 4). Thigh pouches were used as interim or long-term coverage for the testicles in five patients. The subsequent infertility in one patient was probably the result of this procedure, and we advise alternative forms of coverage in younger patients—that is, local flaps or split-thickness skin grafting.

The reported mortality from necrotizing soft-tissue infections to the perineum and genitalia ranges from 7% to 33%.^{2,17,28} In the present series, three patients died (21%). Mortality correlates with the extent of the disease, the delay in surgical treatment, the type of treatment and the presence of debilitating conditions. It is not clear whether any particular combination of organisms provokes a more virulent infection.¹¹ Short-term complications or organ failure was almost always limited to those patients who eventually died, although at least temporary renal failure occurred in six patients. Despite the severity of the infection, long-term complications were noted in only three patients.

Necrotizing soft-tissue infections of the perineum and genitalia represent a spectrum of disease rather than a single clinical condition.^{6,17} The manifestations are a function of the focus of the infection, delay to presentation and treatment, the infecting organism and the type of treatment. Classification schemes have some importance, as subtle differences do exist.⁸ Despite this, initial management, including early examination under anesthesia, surgical incision and debridement should be uniform.

Perineal and scrotal infections are virulent and often fatal, necessitating multiple surgical procedures and a long hospital stay. To limit mortality and morbidity in this high-risk group of patients, strict attention should be given to rapid diagnosis (including radiographs and Gram's stains), early and frequent

surgical debridement, meticulous local wound care, antibiotic therapy directed at both aerobes and anaerobes and early surgical reconstruction.

REFERENCES

1. Fournier AJ: Gangrene foudroyante de la verge. *Semaine Med* 1883; 3:345
2. Jones RB, Hirschmann JV, Brown GS, et al: Fournier's syndrome: Necrotizing subcutaneous infection of the male genitalia. *J Urol* 1979; 122:279-282
3. Lamb RC, Juler GL: Fournier's gangrene of the scrotum: A poorly defined syndrome or a misnomer? *Arch Surg* 1983; 118:38-40
4. Lichtenstein D, Stavorovsky M, Irge D: Fournier's gangrene complicating perineal abscess: Report of two cases. *Dis Colon Rectum* 1978; 21:377-379
5. McCree LE: Fulminating gangrene of the penis. *Clinics* 1945; 4:796-829
6. Bubrick MP, Hitchcock CR: Necrotizing anorectal and perineal infections. *Surgery* 1979; 86:655-662
7. Biswas M, Godec C, Ireland G, et al: Necrotizing infection of scrotum. *Urology* 1979; 14:576-580
8. Majeski JA, Alexander JW: Early diagnosis, nutritional support, and immediate extensive debridement improve survival in necrotizing fasciitis. *Am J Surg* 1983; 145:784-787
9. Burpee JF, Edwards P: Fournier's gangrene. *J Urol* 1972; 107:812-814
10. Flanagan RC, Kursh ED, McDougal WS, et al: Synergistic gangrene of the scrotum and penis secondary to colorectal disease. *J Urol* 1978; 119:369-371
11. Himel HS, McLean APH, Duff JH: Gas gangrene of the scrotum and perineum. *Surg Gynecol Obstet* 1974; 139:176-178
12. Gray JA: Gangrene of the genitalia as seen in advanced periurethral extravasation with phlegmon. *J Urol* 1960; 84:740-745
13. Bernstein SM, Celano T, Silbulkin D: Fournier's gangrene of the penis. *South Med J* 1976; 69:1242-1244
14. Dunai CB: Fournier's gangrene—Report of a case and review of the literature. *Plast Reconstr Surg* 1964; 33:84-92
15. Tan RE: Fournier's gangrene of the scrotum and penis. *J Urol* 1964; 92:508-510
16. Whitehead SM, Leach RD, Eykyn SJ, et al: The aetiology of scrotal sepsis. *Br J Surg* 1982; 69:729-730
17. Rudolph R, Soloway M, DePalma RG, et al: Fournier's syndrome: Synergistic gangrene of the scrotum. *Am J Surg* 1975; 129:591-596
18. Giuliano A, Lewis F, Hadley K, et al: Bacteriology of necrotizing fasciitis. *Am J Surg* 1977; 134:52-57
19. Meleney FL: A differential diagnosis between certain types of infectious gangrene of the skin—With particular reference to haemolytic streptococcus gangrene and bacterial synergistic gangrene. *Surg Gynecol Obstet* 1933; 56:847-867
20. Hite KE, Locke M, Hesseltine HC: Synergism in experimental infections with nonsporulating anaerobic bacteria. *J Infect Dis* 1949; 84:1-9
21. Roberts DS: Synergic mechanisms in certain mixed infections. *J Infect Dis* 1969; 120:720-724
22. Weinstein WM, Onderdonk AB, Bartlett JG, et al: Antimicrobial therapy of experimental intraabdominal sepsis. *J Infect Dis* 1975; 132:282-286
23. Bjornson HS, Hill EO: Bacteroidaceae in thromboembolic disease: Effects of cell wall components on blood coagulation in vivo and in vitro. *Infect Immun* 1973; 8:911-918
24. Fisher JR, Conway MJ, Takeshita RT, et al: Necrotizing fasciitis: Importance of roentgenographic studies for soft-tissue gas. *JAMA* 1979; 241:803-806
25. Gallego HJ: Necrotizing fasciitis. *Arch Dermatol* 1979; 115:507
26. Kaiser RE, Cerra FB: Progressive necrotizing surgical infections—A unified approach. *J Trauma* 1981; 21:349-355
27. McDonald DF, Hulet WH, Cowan JW: Scrotal gangrene treated with oxygen under high pressure. *J Urol* 1975; 113:364-366
28. Campbell JC: Fournier's gangrene. *Br J Urol* 1955; 27:106-113